MODEL DTG-1

Audio Frequency Generator

INSTRUCTION MANUAL

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AUTOMATED INDUSTRIAL
ELECTRONICS CORPORATION
BATESBURG SOUTH CAROLINA

CONTENTS

SECTION

1. SPECIFICATIONS

A. FREQUENCY — RESOLUTION

1000 to 9999 Hz	1 Hz
100.0 to 999.9 Hz	.1 Hz
10.00 to 99.99 Hz	.01 Hz

B. Accuracy - Trimming capacitor in the oscillator circuit allows setting to within +/-1 PPM at room temperature.

C. Stability - Typically +/-10 PPM 0 to 50c.

D. Output - Variable up to 2.5 volts RMS across a 600 ohm load. Output can be reduced by 60 db typically with the level control.

E. Distortion - Less than 3% at full output. (Typically 1.5%)

2. CIRCUIT DESCRIPTION

Referring to the schematic, Q1, the oscillator transistor operates in the fundamental mode with the frequency being determined by Y1, a 7.92 mHz crystal. Trimming capacitor C1 allows setting the oscillator to the precise operating frequency.

The output of Q1 is fed to Q2, a buffering emitter follower. The output of Q2 is then fed through C6 to IC1 for amplification and further isolation of the oscillator. IC1 also developes the CMOS logic levels required for the dual flip-flop stage IC2, whose input is on pin13.

The output of IC2 is a frequency of 1.98 mHz which is fed to the clock input of the rate multipliers IC3, IC4, IC5 and IC6. The output of the rate multiplier chain will be .1000 to .9999 of the 1.98 mHz clock signal dependent upon the setting of the BCD switch S1.

The output of the last rate multiplier on IC6 pin6 is fed to a dual decade divider IC7 pin1 and the range select circuit IC8 pin1. The output of the first decade of IC7 and the second decade output are also fed to the range select circuit IC8. By applying Vcc to either pin2, pin3 or pin10 of IC8, the output pin15 will be the output of the last rate multiplier X1, X.1 or X.01.

The signal from pin15 - IC8 is then fed to the up-down counters IC9 and IC10. The up-down counter further divides the signal by 99 counts up and 99 counts down for actual count of 198. IC11 and IC12 are required within the up-down counter for inversion and toggling of the up-down control line of IC9 and IC10. The outputs of IC9 and IC10 are fed to a binary resistive ladder network consisting of R33 through R40. Adjustment R26 through R32 are required due to slight logic level differences in the outputs of IC9 and IC10.

The output of the ladder network is now a triangular waveform at a frequency determined by the setting of the binary coded decimal switch S1.

2. CIRCUIT DESCRIPTION (Continued)

To develop a sine wave, the triangular waveform is fed to diodes D1 and D2 through IC13. IC13 provides the required voltage gain as well as providing isolation between the ladder network and the sine forming diodes.

Purity of the sine wave is adjusted by R61. The sine wave is fed from D1 and D2 to the level control R63 and into IC14. IC14 is a high gain operational amplifier with feed-back in order to minimize distortion.

The output of IC14 is fed to Q3 through part of the Q3 biasang network R68. Q3 then drives the complementary output stage Q4 and Q5. Again feed-back is introduced with R70 fed from the output stage back to Q3 base resulting in very low harmonic distortion. The 1000 uf capacitor C9 provides DC blocking to the output jack J1.

Regulating circuits IC15, IC16 and IC17 provide regulated DC output voltage at -5 volts, +5 volts and +12 volts. The inputs to IC15, IC16 and IC17 are supplied from the simple rectifying circuits composed of D7, D8, D9 and D10. Ripple filtering is provided by the large electrolytic capacitors C11, C12 and C16.

3. OPERATING INSTRUCTIONS

A. Turn the on-off switch on.

B. Set the thumbwheel switches and range switch to the desired output frequency. The range switch effectively moves the indicated thumbwheel setting down by one or two decades as desired.

C. Adjust the level control for the desired output.

D. Care should be taken that voltages not exceeding 20 volts DC are applied to the output terminals J1 and J2. A suitable high voltage blocking capacitor may be used when high voltage is present in the circuit under test.

4. MAINTENANCE

Low power - high reliability integrated circuits have been used throughout in the design of this instrument. You can expect many years of trouble-free operation. Statistics dictate, however, that some failures will occur. In that event, we recommend you return your DTG-1 to the factory for repair. If it is necessary to make field repairs, the following guides will be helpful.

A. Remove the two top screws on the back panel and slide the top portion of the case back to remove.

B. Check for obvious faults; broken wires, integrated circuits not completely in sockets, broken or discolored parts, etc.

4. MAINTENANCE (Continued)

C. The following trouble-shooting procedures will help you localize a problem. A good high frequency scope and a high impedance voltmeter will be necessary.

D. After the faulty part has been located, remove the screws from the P. C. Board mounting corners and from the transformer. Tilt the P. C. Board up in order to remove and replace the defective part.

5. TROUBLE SHOOTING PROCEDURE (GENERAL)

Functionally, this generator consists of a digitally generated triangle, a linear low distortion amplifier chain and a common power supply. It is helpful to isolate to one of these areas when a problem arises.

A. The power supply can be checked out as follows: By using a DC voltmeter, check for the proper voltages at the outputs of IC15, IC16 and IC17. In the event that any of the voltages are not within 20 percent of their nominal values, 13.2 volts, -5 volts and +5 volts respectively, further trouble shooting in the power area will be necessary.

B. With the thumbwheel switch set at 1000 and the range switch in the X1 position, a 1000 Hz triangular waveform should be observed at the junctions of R33 through R40. If this waveform is present, then the logic circuits IC1 through IC12 are operating properly. If the triangular waveform is not present or is not at the proper frequency, then proceed with detailed trouble shooting of the digital circuits.

C. The linear portion consisting of IC13, IC14 and the complementary output sections, Q3, Q4 and Q5, serve to shape the triangular waveform into a low distortion sinusoidal waveform and to amplify. If a triangular waveform exists at the junctions of R33 through R40 and no output is observed at J1, then further trouble shooting will be necessary within the linear portion of the generator.

6. TROUBLE SHOOTING PROCEDURE (DETAILED)

A. If the trouble has been localized to the power supply, proceed as follows:

1. If no voltage or an improper reading is obtained at the output of IC15, IC16 or IC17, it will be necessary to establish that the IC in question is obtaining the proper input voltage. With a DC voltmeter at pin1 of IC15 and IC17, a reading of between 15 volts and 17.5 volts should be observed. With a DC voltmeter at pin3 of IC16, a reading of -15 volts to -17.5 volts should be observed. In the event that one of these voltages is not present, then a ohm meter check of diodes D7 through D10 would serve to further isolate the problem.

6. TROUBLE SHOOTING PROCEDURE (DETAILED - Continued)

2. If the proper input voltages are present and there is no output on one of the regulator circuits, there is in all probability a direct short on the output terminal of the circuit in question. This can be verified with a ohm meter reading across the output of IC15, IC16 or IC17.

3. Once the trouble has been found and the faulty part replaced, it may be necessary to do some alignment. See Section 7.

B. To localize a problem in the digital portion of the generator, proceed as follows:

1. Using a high frequency scope, check for a 7.92 mHz signal at the input, pins 9, 10, 11 and 12 of IC1. If this is present, then the oscillator section consisting of Q1 and Q2 is functioning properly.

2. With the scope probe at pin13 of IC1, a square wave at a frequency of 7.92 mHz should be observed.

3. The clock inputs for the rate multipliers are obtained from pin1 of IC2. With a scope at pin1 of IC2, a square wave at a frequency of 1.98 mHz should be observed.

4. To check the rate multipliers, the thumbwheels should be set at a reading of 1000. At this setting, the first rate multiplier IC3, will have an output pulse of approximately .5 usec.,at a frequency of .198 mHz. This pulse will be observed at pin6 of each of the rate multipliers, IC3, IC4, IC5 and IC6.

5. The range control circuitry consisting of IC7 and IC8 can be checked with the thumbwheel set as in 4 above. With the range switch in the X1 position, the output of IC8 pin15 will be an inverted pulse of .5 usec. at a frequency of .198 mHz. With the range switch in the X.1 position, the output of IC8 pin15 will be a rectangular waveform at a frequency of .0198 mHz. With the range switch in the X.01 position, the output of IC8 pin15 will be a rectangular waveform at a frequency of .00198 mHz.

6. The up-down counters, IC9 and IC10, receive a clock pulse from IC8 to start the count up or count down mode. When operating properly, the outputs of IC9 pins6, 11, 14 and 2 will be rectangular waveforms at a repetition rate of 1000 Hz. The outputs of IC10 pins6, 11, 14 and 2 will also be rectangular but of longer pulse duration than IC9 and also at a repetition rate of 1000 Hz. These outputs are summed in the binary network of R33 through R40 and will appear triangular at that point. In the event a ramp waveform appears at the junction of R33 through R40, a problem exists with the inverter IC11 or the up-down toggle flip-flop IC12.

C. If trouble is in the linear portion of the generator, proceed as follows:

1. The operational amplifier IC13 will have a triangular waveform at pin6 with R61 adjusted clockwise, as viewed from the top of the P. C.

Board. With R61 adjusted at approximately mid-range, the waveform at the junction of D1, D2 and R62 will be sinusoidal at a level of approximately 400 mvRMS. IC14 amplifies the sine wave to drive the complementary output stage.

2. The output of IC14 pin6 will be at a level of approximately 700 mvRMS. The output at this point will be sinusoidal with very low distortion.

3. Q3, the driver for Q4 and Q5, has a voltage gain of approximately 20 db and raises the sine wave level to approximately 3 volts RMS at its collector.

4. Q4 and Q5 are power amplifiers with no voltage gain and the output at the emitters is slightly less than that at the base. R71 and R72 serve to limit the short circuit current through the output stage.

7. ALIGNMENT

After trouble shooting and parts replacement, alignment may be necessary to produce the purest sine wave output. Switch settings should be as follows:

Thumbwheels	1000
Range	X1
Level	MAX CW

A. With a scope probe at the junction of R33 through R40, adjust R29, R28, R27 and R26 in that order, for a triangle waveform with no shingle effect. Now adjust R30, R31 and R32 in that order to eliminate ripple on the triangle. It may be necessary to repeat these adjustments several times in order to get the best looking waveform.

B. With a scope probe at IC13 pin6, adjsut R58 for a triangle with no clipping on either side.

C. With a scope probe at the output jack, J1, adjust R66 for the most symmetrical waveform.

D. With a distortion analyzer at the output jack, J1, adjust R61 and R58 to obtain minimum distortion.

E. Place a 22 ohm load across the output jacks. With the scope probe on the output, adjust R66 for the best sine wave. If clipping occurs, adjust for symmetry of clip.

F. For best performance, repeat steps A through E several times.

BILL OF MATERIALS DTG-1

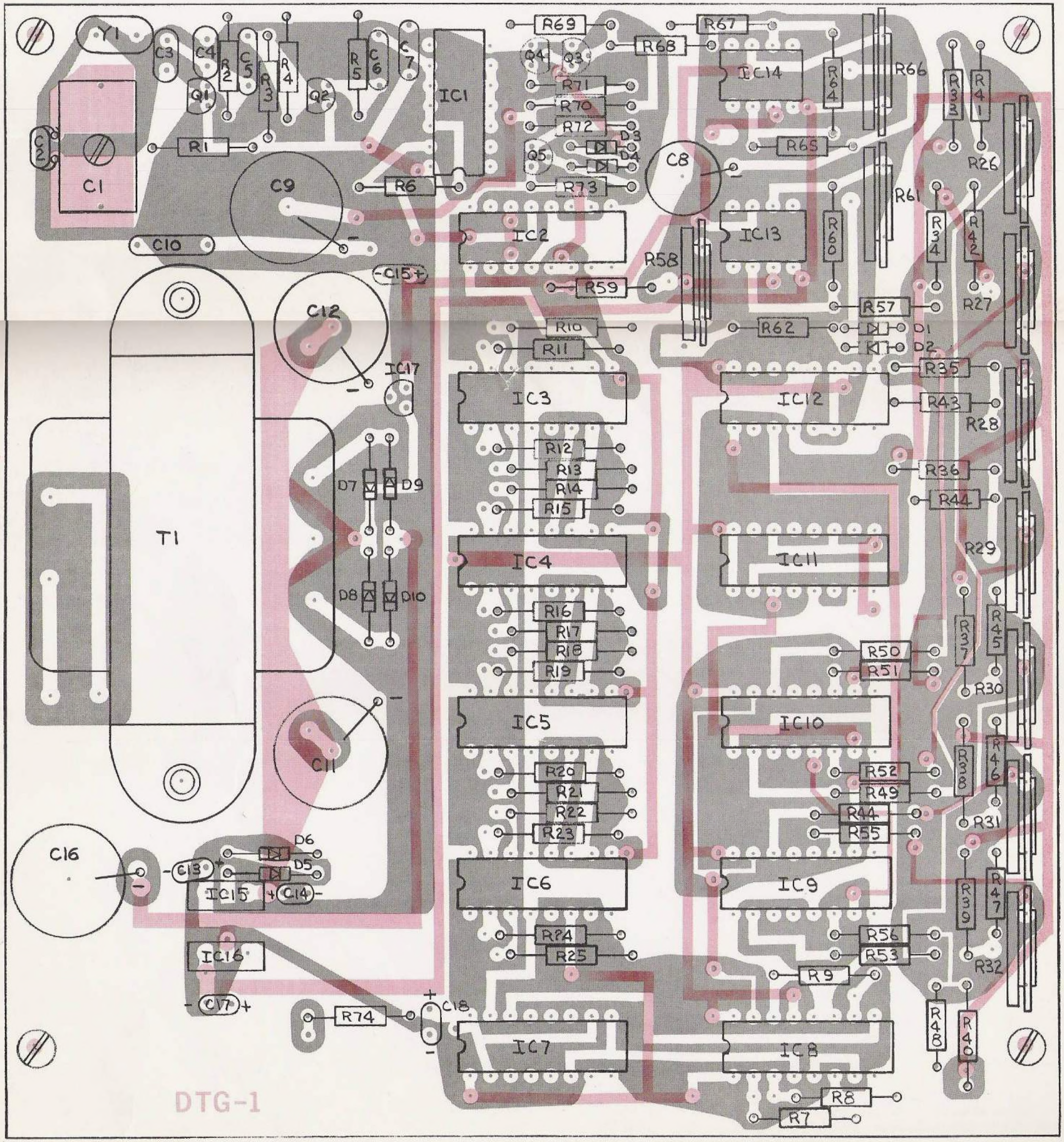
SYMBOL	DESCRIPTION
C1	Trimmer 7-60pf
C2	Mica 39pf
C3	Mica 330pf
C4	Mica 100pf
C5	Ceramic .01uf
C6	C5
C7	C5
C8	Electrolytic 100uf
C9	Electrolytic 1000uf
C10	Ceramic .1uf
C11	Electrolytic 500uf
C12	C11
C13	Tantalum 1uf
C14	C13
C15	C13
C16	Electrolytic 500uf
C17	Tantalum 1uf
C18	Tantalum 10uf
D1-D4	Diode IN914
D5-D10	Diode IN4005
D11	Diode light emitting
F1	Fuse ¼ AMP
IC1	MC14012
IC2	SD4027
IC3-IC6	MC14527
IC7	MC14518
IC8	MC14506
IC9	MC14510
IC10	IC9
IC11	MC14049
IC12	MC14027
IC13	LM307
IC14	IC13
IC15	7812
IC16	79M05
IC17	78L05

SYMBOL	DESCRIPTION
J1	Binding Post, Red
J2	Binding Post, Black
Q1	Transistor, MPS3563
Q2	Q1
Q3	Transistor, 2N3904
Q4	Transistor, MPS6562
Q5	Transistor, MPS6560
R1	Resistor 100K ¼w 10%
R2	Resistor 3.3K ¼w 10%
R3	Resistor 33K ¼w 10%
R4	R3
R5	Resistor 3.9K ¼w 10%
R6	Resistor .39M ¼w 10%
R7-R25	R3
R26-R32	Resistor Variable 1K
R33	Resistor 1.0K 1%
R34	Resistor 1.96K 1%
R35	Resistor 4.02K 1%
R36	Resistor 8.06K 1%
R37	Resistor 16.2K 1%
R38	Resistor 33.0K 1%
R39	Resistor 61.9K
R40	Resistor 133K 1%
R41-R48	Resistor 220ohm ¼w 10%
R49-R55	R2
R56	R5
R57	Resistor 1.0K ¼w 5%
R58	Resistor Variable 5K
R59	Resistor 150K ¼w 10%
R60	Resistor 33K ¼w 10%
R61	Resistor 5K Variable
R62	Resistor 39K ¼w 10%
R63	Resistor 10K Variable
R64	Resistor 150K ¼w 10%
R65	Resistor 15K ¼w 10%
R66	Resistor 5K Variable
R67	Resistor 15K ¼w 10%
R68	Resistor 6.8K ¼w 10%

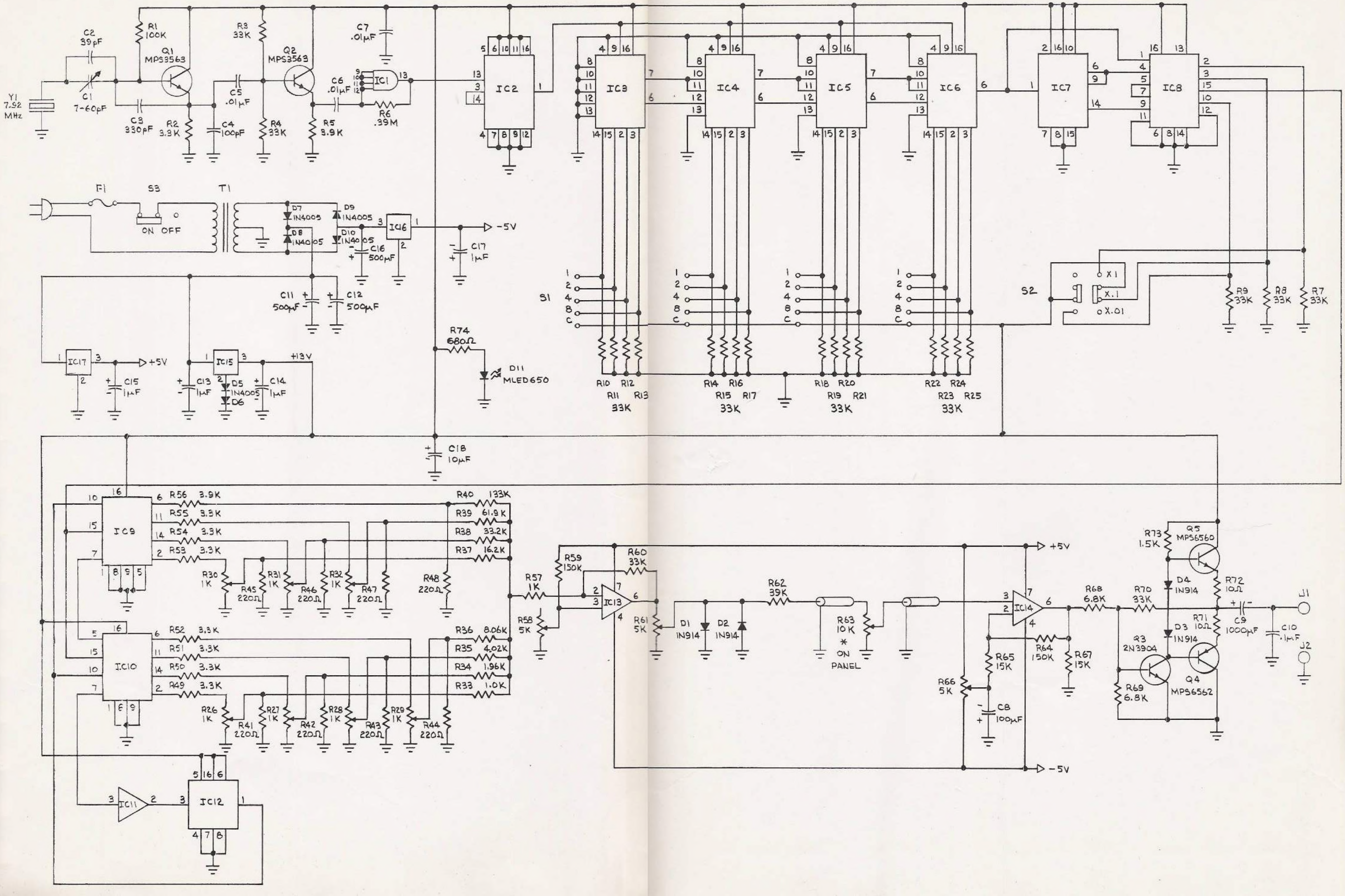
BILL OF MATERIALS DTG-1

SYMBOL	DESCRIPTION
R69	R68
R70	Resistor 33K ¼w 10%
R71	Resistor 10ohms ¼w 10%
R72	R71
R73	Resistor 1.5K ¼w 10%
R74	Resistor 680 ohms
S1	BCD Switch
S2	2pole 3pos slide
S3	2pole 2pos slide
T1	Transformer
Y1	Crystal 7.92 mHz

For parts replacement order by model number, circuit symbol and description. Example: DTG-1 (R68) resistor, 6.8K


Y1
C3
C4
R2
C5
R3
R4
Q1
Q2
R5
C6
C7
IC1
C2
C1
R1
C9
R6
C10
C15
C12
IC17
T1
D7
D9
D8
D10
C11
C16
C13
D6
D5
IC15
C14
IC16
C17
R74
C18
R69
R68
R67
Q4
Q3
R71
R70
R72
D3
D4
Q5
R73
C8
IC14
R64
R66
R33
R41
R65
R26
IC2
IC13
R58
R60
R61
R34
R42
R59
R57
R27
R10
R62
D1
R11
D2
IC3
R35
IC12
R43
R28
R12
R13
R14
R15
R36
R44
IC4
IC11
R29
R16
R17
R18
R19
R50
R51
R37
R45
R30
IC5
IC10
R20
R21
R22
R23
R52
R49
R44
R55
R38
R46
R31
IC6
IC9
R24
R25
R56
R53
R39
R47
R9
R32
IC7
IC8
R48
R40
R8
R7

DTG-1


Y1 7.92 MHz
C1 7-60pF
C2 39pF
C3 330pF
C4 100pF
C5 .01μF
C6 .01μF
C7 .01μF
R1 100K
R2 3.3K
R3 33K
R4 33K
R5 3.9K
R6 .39M
Q1 MPS3563
Q2 MPS3563
IC1
IC2
IC3
IC4
IC5
IC6
IC7
IC8
F1
S3
ON OFF
T1
D7 IN4005
D8 IN4005
D9 IN4005
D10 IN4005
IC16
C16 500μF
C17 1μF
-5V
C11 500μF
C12 500μF
IC17
+5V
C15 1μF
IC15
+13V
C13 1μF
D5 IN4005
D6
C14 1μF
R74 680Ω
D11 MLED650
C18 10μF
S1
S2
X1
X.1
X.01
R9 33K
R8 33K
R7 33K
R10 R12 R11 R13 33K
R14 R16 R15 R17 33K
R18 R20 R19 R21 33K
R22 R24 R23 R25 33K
IC9
IC10
R56 3.9K
R55 3.3K
R54 3.3K
R53 3.3K
R52 3.3K
R51 3.3K
R50 3.3K
R49 3.3K
R40 133K
R39 61.9K
R38 33.2K
R37 16.2K
R36 8.06K
R35 4.02K
R34 1.96K
R33 1.0K
R30 1K
R31 1K
R32 1K
R48 220Ω
R45 220Ω
R46 220Ω
R47 220Ω
R26 1K
R27 1K
R28 1K
R29 1K
R41 220Ω
R42 220Ω
R43 220Ω
R44 220Ω
IC11
IC12
R57 1K
R59 150K
R58 5K
R60 33K
R61 5K
IC13
D1 IN914
D2 IN914
R62 39K
R63 10K * ON PANEL
IC14
+5V
-5V
R68 6.8K
R64 150K
R65 15K
R66 5K
R67 15K
C8 100μF
R70 33K
R69 6.8K
R73 1.5K
Q5 MPS6560
D4 IN914
D3 IN914
R71 10Ω
R72 10Ω
Q3 2N3904
Q4 MPS6562
C9 1000μF
C10 .1μF
J1
J2

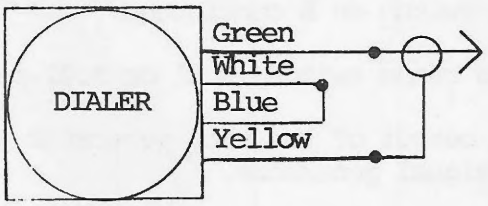
OPTION 3

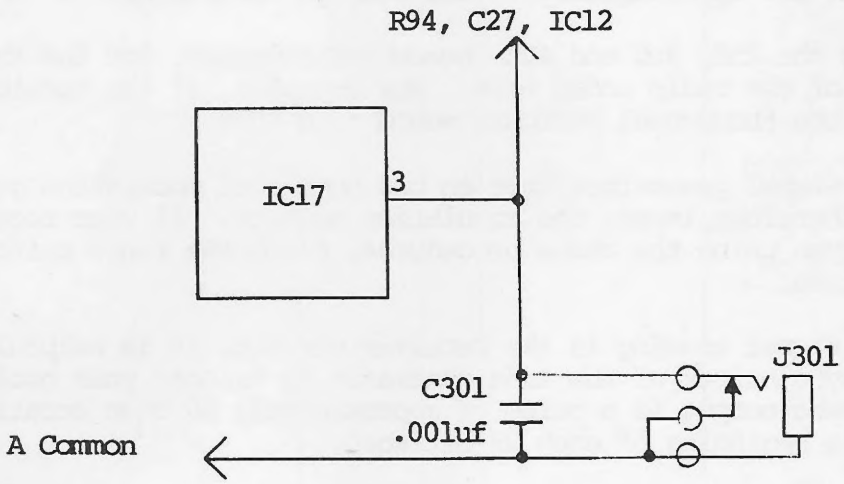
Operating procedure for using Option 3, Telephone Dialing:

1. Adjust the A decades and range switch to the desired frequency, 2805, 1500, etc.

2. Set the Mode switch to A CONT.

3. Plug the dialing mechanism into the jack on the left panel of the generator. Using the plug provided, see below for wiring to the dialer.





SCHEMATIC REVISION WITH OPTION 3, TELEPHONE DIALING

OPTION 8

Instructions for using the Digital Tone Squelch Option:

Step 1: Place the first thumbwheel switch in position Zero. Normally, this switch is prevented from going to Zero to assure that maximum resolution will be achieved when the unit is used as a tone generator.

When this option is added to the 2TSG-1, the B Channel is used as the digital tone squelch generator. In this case, it is necessary to put the mode switch on B continuous.

Step 2: Place the range switch in X1 or X.01 position.

Step 3: Feed the output of the tone generator to the external modulation jacks on your signal generator.

Adjust the level control of the tone generator to approximately mid position. Using the modulation level control on the signal generator, adjust for approximately .5 kHz average deviation.

Step 4: Using the 2nd, 3rd and 4th thumbwheel switches, set for the squelch code of the radio under test. For example: If the squelch code is 070, the thumbwheel switches would read 0070.

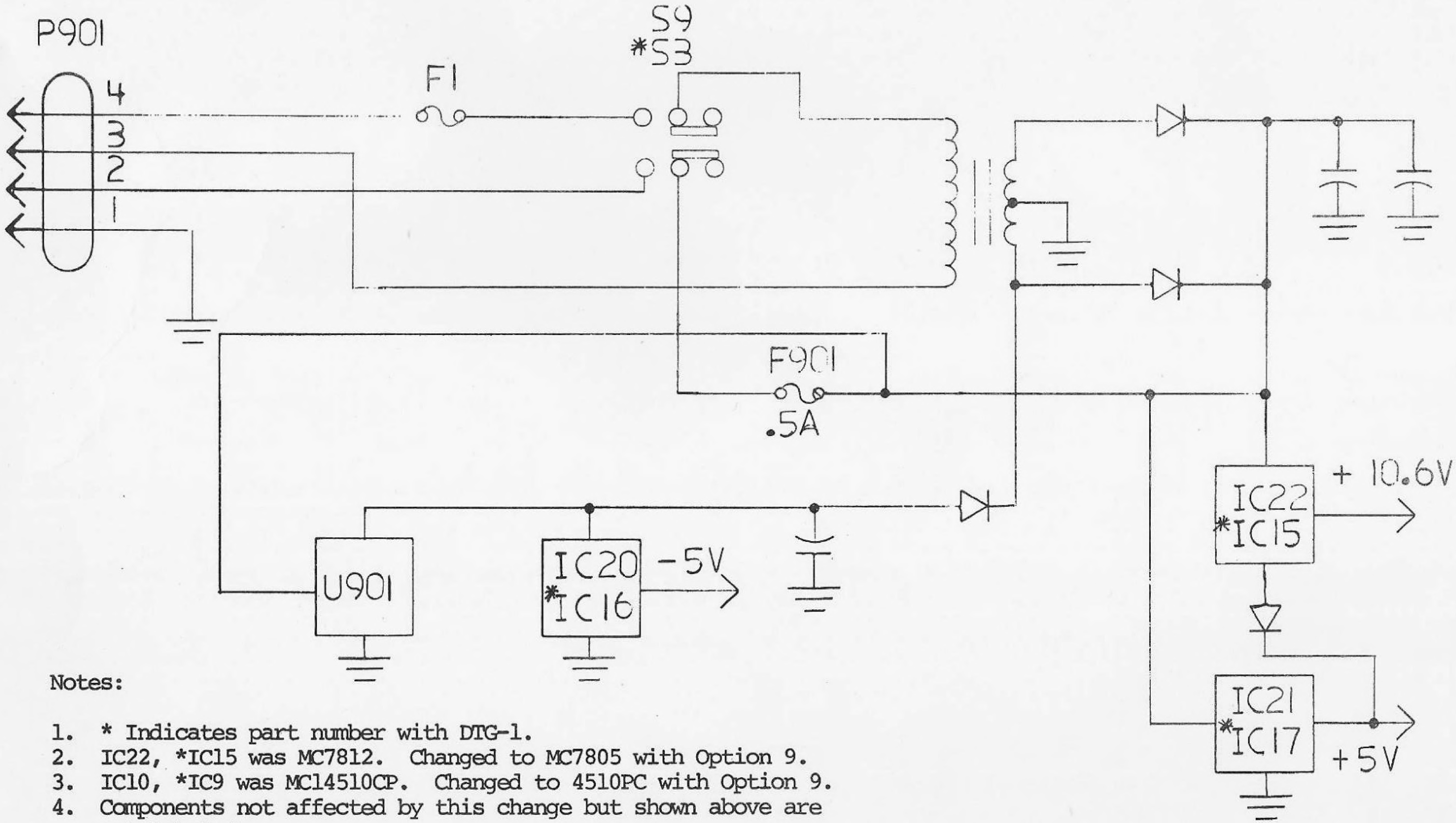
Step 5: Some signal generators have an odd number of modulation gain stages and therefore invert the modulation pattern. If your receiver does not open using the above procedures, place the range switch in the X.1 position.

Step 6: When signal tracing in the receiver circuit, it is helpful to use the sync output of the tone generator to trigger your oscilliscope. The sync output is a pulse of approximately 50 usec duration occuring at the beginning of each 23 bit word.

NOTE: If you are injecting the 23 bit word into a high impedance audio stage, it may be necessary to use a small coupling capacitor between the output of the tone generator and the input of the circuit under test.

Step 7: When returning to normal tone generator operation, it is necessary only to move the 1st thumbwheel switch away from Zero. This automatically programs the range switch to act as a scaler.

Schematic Revisions for Model 2TSG-1 and Model DTG-1
with Option 9 (AC/DC Operation)



Notes:

1. * Indicates part number with DTG-1.
2. IC22, *IC15 was MC7812. Changed to MC7805 with Option 9.
3. IC10, *IC9 was MC14510CP. Changed to 4510PC with Option 9.
4. Components not affected by this change but shown above are not labeled.